Ohio Agricultural Experiment Station.

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WOOSTER, OHIO, JANUARY, 1898.

THE LUNG AND STOMACH WORMS OF SHEEP.

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BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 91. JANUARY, 1898.

LUNG AND STOMACH WORMS IN SHEEP.

INTRODUCTION, BY C. E. THORNE.

For an indefinite period sheep in Ohio have suffered from an anæmic disease, manifested chiefly in lambs or yearlings, and known as "paperskin," "whiteskin," etc. In 1873 the late Dr. N. S. Townshend called attention to this disease, in a paper published in the Ohio Agricultural Report of that year, and from which we republish the following extract as giving a very clear description of its symptoms.

"Sheep are subject to an affection which in Ohio is known as whiteskin, paperskin, pelt-rot, etc. In the British Isles the same disease is called hoose, or husk. In Germany it is called Lungenwurmseuche, or Lungenwurmhusten.

"In its early stages the disease is characterized by fits of coughing and sneezing, with discharge of mucus from the nostrils. The affected sheep stretches the neck, gapes, rubs the nose upon the grass, and gives other evidences of difficult breathing or of irritation of the air passages. After a time the animal loses flesh and strength, the eyes and mucous membranes are usually pale, a diarrhœa comes on, and rapidly hastens the general emaciation. The wool becomes loose, is easily pulled off, or comes off in patches spontaneously, leaving the skin peculiarly pale and bloodless, and hence the name of whiteskin, paperskin, etc. Finally, the sheep dies from exhaustion, except, in a few cases, when in earlier stages the sheep dies from suffocation. Lambs during their first year are most subject to this disease, though older sheep are not exempt.

"On examination of the bodies of sheep that have died in this way, a noticeable fact is the extreme emaciation; the fat is all gone, and the muscles are attenuated, pale and flabby. The liver and spleen are paler than usual, the intestines exhibit externally no evidence of inflammation, but often do present an excessive degree of knottiness, or tuberculization. The interior of the intestines is reddened, and shows the result of continued irritation, in some places the intestinal tube is much contracted, or almost closed by the multitude of tubercular masses. These masses when divided, are mostly gray or greenish in color, and of a cheesey consistence Some of them are calcareous, and cannot be cut with a knife.* The heart is found paler than usual; the lungs are sometimes smooth and comparatively healthy looking on the surface; in other cases, like the bowels, they are covered

*See Prof. Brown's description of the work of Strongylus rufescens, p. 168

with little knots. Cutting into the lungs, portions are found in a healthy condition and thorougly permeable to air; other portions, where inflammation has existed have become solid and impervious. The windpipe contains a frothy mucus, the divisions of the windpipe or bronchial tubes contain more mucus, and by the redness of the interior surface show the effect of severe irritation. When the subdivisions of the bronchial tubes are opened, they are found full of white, thread-like worms, sometimes extended at length, but more frequently rolled up in bunches. These worms, when fully mature, in the spring of the year, are from two to four inches in length; the males scarcely exceed two inches, and are of a light yellow color; the females are considerable larger, and more nearly white. That these worms have caused the cough and difficult breathing, and subsequent wasting and death of the sheep, there cannot be a reasonable doubt.

"That sheep were subject to worms in air passages, was well known many years since. Youatt's work on the Breeds, Management and Diseases of Sheep, which was published in 1837, says: Several cases have come under the author's observation where the air passages of sheep were filled by worms, and the animals destroyed by the inflammation which they had set up. From Youatt's time to the present the liability of sheep and young cattle to suffer from such parasites has been recognized by European veterinarians. Within a dozen or fifteen years attention has been more especially directed to this affection by the serious losses that have resulted from it both in Germany and in Great Britain. In some seasons the greater part of the lambs or yearlings over large tracts of country have died from this disease, amounting in the aggregate to several millions. In the United States the liability of sheep to be destroyed by lung worms, and the identity of the mischief produced by these parasites with the disease known to American farmers as whiteskin, etc., was prominently brought to public notice in January, 1873, by Dr. Cressey, Veterinary Surgeon to the Connecticut State Board of Agriculture. In Ohio, the dependence of whiteskin upon parasites in the lungs was probably first demonstrated at the Ohio Agricultural College at Columbus, and a report of the examination of sheep that had died of this disease was published in the Newark *American* of March 27, 1874.

"The parasite found in the lungs of sheep is known to zoölogists as *Strongylus bronchialis*, *Strongylus filaria*, *Filaria bronchialis*, etc. It belongs to the class of nematoid or thread-like worms. When fully grown, the males are about two inches in length, and the females three or four inches. In the spring the females are found full of ova, and the young worms within the eggs appear sufficiently developed to maintain an independent existence. Unfortunately, the complete natural history of the parasite is not understood. That in another stage of its life it infests some other animal or insect, or is to be found in the earth, or in water, or upon herbage, is considered probable, though in none of these situations has it yet been recognized Strongyli are found in most of our domestic animals. Calves suffer as much, or even more, from their attacks than sheep. Colts, pigs, goats, deer, dogs and rabbits have all been found infested by them. Since the latter part of the last century it has been known that the disease of poultry, called gapes, depended on thread-worms in the windpipe. Quails, meadowlark, and many other birds, are similarly affected, and even fish have been found infested with strongyli. Insects, such as crickets, grasshoppers and caterpillars, are preyed upon by parasitic, nematoid worms. The *Gordius aquaticus*, or hair snake, is supposed to pass one stage of its existence as a parasite within the bodies of the insects just named; another portion of its life it lives in mud or in water. Whether the changes of strongyli are similar to those of gordii, remains to be proved. If farmers were more frequently good naturalists, their peculiar opportunities for observation would enable them to solve many of these mysteries. In Great Britain and on the continent of Europe the idea prevails that the ova, or young strongyli, are taken with food or drink in

the summer or autumn, and that sheep feeding on wet, springy or overflowed lands, are more liable to be affected with these parasites. Until the changes of the worm are better understood, it will be impossible for farmers to devise effectual measures for the protection of their flocks from its ravages."

It will be observed that in this paper Dr. Townshend speaks only of parasites in the lungs. In 1885, however, he contributed a paper to *Farm and Fireside*, in which he described *Strongylus contortus*, as found in the fourth stomach and intestines of the sheep.

In the annual report of this Station for 1886 the Veterinarian, Dr. H. J Detmers, describes the same parasite, as found by him in the fourth stomach of a lamb which had been brought to him from Franklin county,* and the files of the *National Stockman and Farmer* indicate that strongyles were unusually prevalent in both lungs and stomachs of lambs that year.

For several years thereafter they seem to have been less abundant, but a fresh outbreak apparently followed the wet summer of 1896, as for two years past there has been general complaint of loss of lambs, with symptoms which indicate the presence of one or both these pests.

In fact, it is being observed of late that when one of these parasites is present the other is generally also found, the conditions favoring the development of the one being generally also conducive to the increase of the other, and these two are frequently accompanied by a third pest—a tape-worm—found in the small intestines. The mischief which these worms may occasion is illustrated by the following letter, published in the *National Stockman and Farmer* for October 3, 1889:

"I would like to give the sheep breeders, and especially the readers of The Stockman, a little of my experience of late. I have been breeding sheep all my life, and do not profess to know much yet, but think I have learned something at this late day. I had a flock of eighty lambs, half-blood Shropshires—just regular beauties—and I was feeling very proud of them. During the rush of harvest I did not see them more than once a week, and when I got leisure to be among them I noticed that some of them were on the decline, and of course they were taking the 'paper skin.' In a few days they began to die. One or two would be dead every morning, until I have but forty-six left out of the eighty.

"On meeting a friend of mine a few days ago I found that he had the same experience with his Black-top Merinos, and talking the matter over we concluded to make a post mortem examination. This I did, and found the small stomach literally filled with a small red worm, like the pin worm. The plies of the stomach were filled in rolls of these little worms, and the mucous membrane was all eaten off. Passing on to the small bowels, they were filled in places with long worms, resembling tape-worms, which were in joints, and would stretch out fifteen or twenty feet; and where they were the entrails were eaten as thin as tissue paper."

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*In the report of the Veterinarian of the U. S. Department of Agriculture, for 1883, Dr. Detmers had called attention to *S. contortus* as being one of the causes of the disease of sheep in Texas, locally known as Lombriz.

Three valuable contributions to our knowledge of these parasites have recently been published, namely:

1. Parasites of the Lungs of Sheep, by Professor G. T. Brown, C. B.

2. Parasitic Gastro-enteritis in Lambs, by Professor J. McFadyean, B. Sc., M. B., both of the above appearing in the Journal of the Royal Agricultural Society of England for March, 1897, and:

3. The Pernicious and Epizootic Anæmia of the sheep of the School of Grignon (France) its causes and its cure, by M. Ch. Julien, published in *Annales Agronomiques* for November and December, 1897.

Professor Brown deals exclusively with the lung parasites, while the work of Professors McFadyean and Julien relates chiefly to the parasites of the fourth stomach, in which they have both found, not only *Strongylus contortus* Rud., but also a smaller nematode, about half the length of *S. contortus*, and with regard to which both authors are in doubt as to whether it is a different species or merely a younger form of the same, the English writer inclining to the former view and the French one to the latter. Each of these writers appears to have been entirely unaware of the work of the other, and each proposes a name for the newly discovered nematode, McFadyean suggesting *Strongylus cervicornus*, and Julien adopting provisionally the name *S. instabilis*, proposed by Railliet in 1893. Both writers agree, however, in ascribing to these smaller worms a large part of the mischief accomplished.

These questions of natural history are not without importance, for upon their correct solution must depend, in large measure, the success of methods of prevention or treatment.

Both authors referred to agree in the opinion that low, wet pastures favor the development of the parasites, and that permitting the sheep to drink from stagnant pools, contaminated with sheep excrement, may cause a rapid spread of the infection, since the droppings of infested sheep have been generally found to be carriers of the eggs and embryos of the parasites.

In view of the great losses which the farmers of Ohio have recently suffered from these parasites—losses which we have good reason to believe are largely preventable—Mr. Jos. E. Wing, of Champaign county, who has had considerable experience in the treatment of affected sheep, has been requested to furnish the results of his experience for publication by this Station, which he has done in the following pages.

This publication is offered in the hope that it will direct the attention of farmers towards the true source of much of the loss in their flocks, and that it will prepare the way for a more thorough study of the occurrence and life history of the parasites named than has yet been made.

To this end, it is requested that farmers who may have suffered any considerable loss of lambs during the last two years from symptoms such as those described by Mr. Wing will inform the Station of the fact, giving number lost, and present condition of their flocks.

THE MORE COMMON PARASITIC DISEASES OF LAMBS.

BY JOS. E. WING.

THE LUNG PARASITES.

More or less knowledge of the parasites of the lungs has been in possession of sheep owners for many years. Powers, in his very valuable work on "The American Merino," gives a very clear description of them and states that in 1882, the season being wet, the mortality among the lambs was very great throughout Ohio.

It is probable that these parasites are not now so numerous or so destructive as they once were, when more sheep were kept and flocks were larger, yet evidence in plenty exists to show that they are very widely spread over the state and that they cause much loss, not only by death but more often by lowering the vitality so that the lambs do not thrive as they should.

There are three species of parasites that work harm in the lungs or bronchial tubes of the sheep: 1. The white thread-worm (*Strongylus filaria*), which inhabits the tubes of the lungs. 2. The red thread-worm (*Strongylus rufescens*), which is found in patches or nodules in different parts of the structure of the lungs. 3. The hair lung-worm (*Pseudalius ovis*), which is coiled up in small, tubercle-like spots throughout the lung structure, and is often very abundant on the surface of the lungs, directly underneath the pleural membrane

THE WHITE THREAD-WORM (*Strongylus filaria*).

This is the best known of the lung-worms, perhaps because the most easily found. Shepherds have for a long time been accustomed to slitting the windpipe and larger bronchial tubes in search for the masses of threadlike worms that are often found there, sometimes almost blocking up the tubes so as to make breathing very difficult or impossible.

Concerning the life history of this worm there is not much definitely known. It reaches its full developement in the lungs of the sheep and deposits many eggs that contain living embryos, which escape soon after being deposited in the lung-tubes, but there seems to be no evidence that these young worms ever reach maturity or themselves propagate their kind in the body of the sheep until after they have passed a stage of existence in the ground.

Very many experiments have been made by gentlemen in England to learn how the worm passes its second stage of existence. In simply moistened soil the young worms were found to live for at least five months, and during that time to make some progress toward perfect development. Further experiments developed the very suggestive fact that the lung-worms lived in the bodies of the common earth-worms and underwent certain changes there.

"To sum up the points in the life history of the *Strongylus filaria* so far as the latest investigations have brought them to light: It appears that eggs containing living embryos and embryos which have got free from the egg, are expelled from the bronchial tubes of infested sheep in enormous numbers. It is also established that the adult worms have only a temporary residence in the lungs, but whether they are expelled living or dead has not been ascertained with certainty; nor is it known what becomes of them when they quit the lung-tubes. The embryos, it has been proved, live for months in wet earth: they may be dried by the heat of the sun without being destroyed; nor does the frost seem to do them any serious damage. In common with the other larval forms of *Strongylus*, they are swallowed by earthworms and again rejected after having gone through certain changes; but with the evidence obtained from the examination of many hundreds of earth-worms, it is impossible to believe that even a considerable proportion of the embryos which are expelled from the sheep's lungs are disposed of in this way.

"It is not unlikely, however, that a large number become parasitic to certain plants and in that position acquire a sufficient development to fit them for residence in a warm-blooded animal. Here, again, however, the evidence is utterly insufficient." *

THE RED THREAD-WORM (*Strongylus rufescens*) AND THE HAIR-WORM (*Pseudalius Ovis*).

Few writers on sheep have made reference to these two parasites. I look in vain for notice of them in Power's "American Merino" or Stewart's "Shepherd's Manuel," the two books most in use and best adapted to the needs of the American Shepherd. They may be comparatively rare in America or, more likely, we have not learned to recognize them when they are found in our flocks.

"It is a remarkable fact in the history of the *Strongylus rufescens* that it is chiefly known by the presence of its embryos in the lungs. To a number of writers on the history of parasitic diseases the creature must have been more or less a myth, as, in their descriptions, they speak of it variously as being on the one hand a few millimeters long, and on the other as reaching the length of six inches. Very much in the same way, the embryos which are found in abundance in the lungs of the sheep, the bronchial tubes of which are infested with the *filaria*, have been described over and over again as embryos of that worm." †

This investigator considers at some length the question as to whether these two worms were are not merely forms of the same parasite, leaving the question an open one. To quote again,

"It is more than probable that the stock-owners will not feel very much interest in the possible solution of the problem as to the exact position of the *Strongylus rufescens* in natural history. It will, however, concern him very much to know that the worm commits terrible havoc when it gets into the lungs in large numbers. It is almost a constant inhabitant of those organs in all parts of the country, and probably wherever sheep are to be found.

"The mature worm, it has been already explained, is easily overlooked; indeed, it is very difficult to obtain a perfect specimen. The embryos, however, and the

* G. T. Brown on *parasites of the lungs of sheep*, Jour. Roy. Ag. Society, Vol. VIII, Part I.

† Brown, loc. cit.

eggs, with portions of adult worms, can be found without trouble, but only by the aid of the microscope. On examining the lungs of a sheep from a few months old, it is usual to observe on the borders of the lungs, and, according to the extent of the invasion, more or less distributed through the structure of the organ, grayish white or sometimes dull red nodules varying in size from a pea to hazel nut. In some advanced cases which have been under observation lately in a flock in the south of England, the greater part of both lungs of affected sheep had been converted into a white, fibrous mass, scattered through which were nodules containing thousands of embryos and numerous mature worms.

"In the majority of the nodules of all sizes the center was occupied by a small mass of greenish yellow, pasty or cheesy substance, in which the eggs and embryos were abundant. The adult worms however, apparently prefer a position on the outside away from this greenish substance, probably because they have already exhausted whatever nutritive material the mass might have contained. It will be apparent from the above observation that the effects of the *Strongylus rufescens* on the lung structures vary from comparatively insignificant changes, as the result of the irritation which they cause, to actual obliteration of the greater part of the normal structure and the substitution of a fibrous tissue in its place. It would be expected that such extensive changes would be fatal, and in the case which has just been referred to, in which a large number of sheep suffered from this fibrous degeneration of the lungs, the losses were very considerable, and the animals which partly recovered remained in an emaciated condition.

"One circumstance which renders the *Strongylus rufescens* a more objectionable visitant than the ordinary thread worm, is the permanence of its residence Whether the invaders are few or many in number, and confine themselves to the borders of the lungs or spread over the greater part of it, they seem to occupy themselves in feeding on the material which is at hand, and depositing eggs, which are subsequently hatched, a large number of embyros being set free, and causing excessive irritation by their incessant movement. It would appear to be the case that nothing short of the pressure which is exerted by the steadily increasing density of the fibrous deposit has the effect of destroying the brood. This process, which is comparatively harmless, when the worms are few in number, is fatal to the sheep when the parasites have invaded nearly the whole of the lung-structure."*

TREATMENT OF PARASITIC LUNG DISEASE OF THE SHEEP.

"* * *. It is well known that the infested animals themselves provide the means for the continuance of the parasities which feed on them. A few sheep containing in their lungs the worms which have been described, even though they might not themselves give any evidence of suffering from them, would contribute to a considerable extent to the contamination of the land on which they feed. When the few become hundreds the mischief is necessarily increased in proportion. Overcrowding is unquestionably one cause, and an important one, of the contamination of sheep lands; and constant feeding on the same grounds is another * * * Exposure and deficiency of food necessarily induce debility of the system of the sheep, and in this state they become perfectley easy victims to the parasites which infest them. Again, it may be safely affirmed of every pasture on which parasites are abundantly present, that the circumstances are favorable to their existence, in other words, that there is a redundancy of moisture in the soil or in patches. Stagnant pools, or even small, scarcely noticeable puddles, may harbor myriads of the germs of parasites, ready to take up their residence in a warm blooded animal.

* Brown, loc. cit.

"It must be obvious that very little will be gained by limiting preventive or curative measures to the diseased animals, while the causes of the disease, both direct and contributory, are allowed to flourish undisturbed." *

Probably it is seldom wise to attempt to cure sheep or lambs that are much affected with any species of lung-worm. As soon as the characteristic cough is heard it may be wisest and most profitable to send the animal at once to market. The trouble and expense of treatment and the uncertainty of it and the length of time required to cure the animal and get it in good condition after the attack make it very unprofitable to the owner. Besides, there is the constant infection of grass and by the diseased animal while being treated. There are, however, cases where valuable lambs are affected and a cure, if effected before the disease has progressed very far, may leave the sheep in strong and serviceable condition.

The practice of smoking or fumigating the lambs for lung-worm is very old, and is looked upon by some shepherds with considerable favor. As practiced by the experienced shepherds of Ohio the process is as follows: The lambs are confined in a close room, or beneath a tent of thick canvas, and upon some live coals in a kettle a quantity of sulphur is thrown. The attendant remains with the lambs, keeping his head on a level with theirs, and when he can no longer endure the fumes he opens the door and allows the lambs to go out. In some cases the lambs are kept in for a short time after the man is driven out.

Care must be observed not to expose the lambs too long to the fumes of sulphur. The writer killed six very promising lambs out of seven in this way, the seventh one, however, recovering and making a sound animal.

The more promising treatment is that of injecting turpentine mixed with olive oil into the windpipe. There is no particular risk in performing this operation; it is harmless to the sheep, and in many cases will effect a cure.

The method of procedure in this treatment is to first carefully mix two parts of olive oil with one part of turpentine, measuring from one to three spoonsful for a dose. A hypodermic syringe is needed for injecting this, and if many lambs are to be operated upon, it will be well to purchase a regular veterinary syringe, which costs about $2.25.

The assistant holds the animal firmly, in a sitting position, and the operator grasps the windpipe with the left hand, taking care that he is below the swallowing point. Care must be taken not to get hold of the great vein; the large, firm windpipe is very easily distinguished. Bringing it near to the front, the needle is carefully pushed through the walls of the windpipe, and the dose injected. As the hypodermic needle is small there is no bleeding and no ill effects should follow the operation, unless the operator has accidently injected into the vein rather than the

* Brown, loc. cit.

windpipe. If the puncture is made too high up the dose will be swallowed into the stomach. The lamb appears stupid and sleepy for a short time, being probably affected by the fumes of the turpentine. If not badly affected no further treatment will be needed beyond good feeding, but some cases will need another operation after ten days.

I think it safe to say that no treatment by giving medicine through the stomach is of any use, except that the stomach worms are often found in the same host, and the destruction of them will enable the animal to sooner regain its vigor and thus make the conquest of the lung-worms an easier matter.

It is clearly impossible to so saturate the sheep, through the stomach, with medicinal substances as to destroy parasites or even to inconvenience them without first destroying the life of the sheep. On this point I quote:

"The embryos of the worm have been found alive and perfectly active in sheep which have been treated with a course of arsenic, sulphate of iron, and turpentine, the treatment being carried over several weeks, and the subjects of it being at last killed by an injection of prussic acid. They have been found alive in a portion of lung which had been kept for several hours in a solution of corrosive sublimate. After this experience it would be absurd to suggest that any drug which could be introduced would kill these worms even if it killed the sheep." *

A recent experience of the writer would seem to indicate that if an intermediate host is necessary to the development of the lung-worms the period of time passed in the intermediate state it not necessarily very long. A flock of 75 strong, healthy, ewes, with about 45 large, winter lambs was put in a high, rolling, bluegrass pasture of forty acres. No sheep were on this pasture the preceding year, nor were there any sheep ever on it that showed noticeable signs of being infested with parasites. Of the ewes one might say that they were an exceptionally strong and healthy lot.

The season being good the grass grew up very luxuriantly, so that it was much grazed on some slopes near a spring and not eaten to any extent over the other parts of the pasture. Those parts that were grazed closely became thickly strewn with the droppings of the sheep and no doubt were infected from their nostrils as well.

The water came from a spring which afforded a slender stream and formed small pools from which the sheep drank.

The older lambs thrived exceedingly well until August, when four died rather suddenly, without first showing sufficient signs of sickness to attract attention.

During June and July about 20 lambs were born on the pasture. The grass being good they seemed to thrive for a time, but in about 45 days they became emaciated, coughed badly, and although treated through the stomach all died with well marked symptoms of lung-worm.

* Brown, loc. cit., speaking of *S. Rufescens.*

The older lambs, when removed from the pasture, continued to thrive, and the ewes remained apparently healthy, It is evident that the small lambs grazed on the short grass and perhaps also drank in parasites with the half stagnant water.

It is evident that older sheep in seeming perfect health may infect lambs with lung-worm (and doubtless stomach worm) to a fatal extent, and this during a single season.

"The best hope of success must rest on the use of means to intercept the young worms before they can effect an entrance into the body of the intended host. The farmer's aim, indeed, should be to treat these invisible enemies as he would if he could see them in their thousands creeping about the pastures as he walked over the farm.

"When the worms have once taken up their position, one essential thing which can be done, without neglecting medical treatment, is to support the system of the infested animals so as to enable them to resist the effects of the invasion."[7]

THE STOMACH WORM (*Strongylus contortus*, Rud.).

Early in the summer of 1896 complaints began to be made from nearly every part of Ohio that some new disease was destroying the lambs. As the season progressed the disease became more prevalent and destructive. Medicines, so far as tried, seemed to be of little use. The trouble was given various names, "lamb cholera," "scours," "constipation," and was attributed to the drinking of stagnant water, unusually abundant because of the unusual rainfall, to the rank and watery grass, to the drenching of the lambs by the rains.

The advent of cold weather found nearly 40 per cent. of the lambs dead or debilitated to the extent that they were practically worthless. Lambs that had been affected and seemingly recovered either died in the winter feed lots or failed to thrive to the point of profit.

Those who attributed the disease to the unusual rainfall and its resultant watery grass were confident that this year, (1897) would not see a repetition of the trouble. Others, attributing the disease to the drinking of stagnant water, drained their pastures and, furnishing only pure water from springs or deep wells, thought thus to avoid its recurrence.

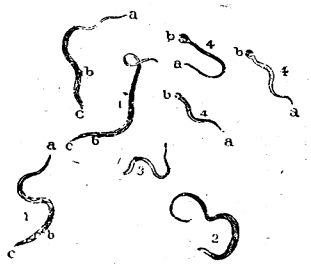
These assumptions have been justified by events only in part. On many well drained pastures, supplied with pure water, there has been very severe loss again this season. Wherever lambs have been pastured on land where sick ones fed last year there has been sickness and death among them. While it is a little difficult to explain why the stomach worm parasite should have been so suddenly brought to our attention as it was in 1896, it is not a question that should be disputed that it was the direct cause of most of the sickness and death among the lambs both during '96 and '97.

While the stomach worm, (*Strongylus contortus*) is undoubtedly responsible for most of the deaths among our lambs yet it is very

generally true that when the Strongylus has lodgement within the animal other parasites are found helping on the fatal work.

It is strange that in most books on sheep and their diseases no reference or description is devoted to this parasite or to the disease that it causes. From this fact we may infer one of two things: either that the parasite is of comparatively recent introduction, or that, being as it is a very small worm and difficult sometimes to find by one inexperienced in looking for it, it has been overlooked by earlier writers and its consequences attributed to other causes.

I believe the latter to be the true supposition. This parasite is a small, slender, thread-like worm, about an inch in length when fully developed. It lives in the fourth stomach of the sheep. To find it one must turn the contents out of the stomach, and unless present in great numbers must look very carefully. The natural size is shown in the accompanying figure, reproduced from the report of Dr. H. J. Detmers on diseases among sheep in Texas, published in the report of the U. S. Department of Agriculture for 1883:



Group of *Strongylus contortus*, natural size.

1. 1. 1. full grown females.
2. not fully developed female.
3. young female.
4. 4. 4. full grown males.
a. a. a. a. head.
b. b. b. b. genital organs of both sexes.
c. c. c. tail and anus of female.

The natural history of this worm is very simple. It is found in nearly all sheep and in small numbers seems to do little or no injury to its host. The males and females are present in the stomach and, when matured, copulation occurs and the female becomes filled with fertile eggs, each containing a living embryo. When these eggs are ripe the female passes out of the stomach into the intestines and is discharged. Dr. Detmers says that she dies before she is discharged from the sheep's body. The eggs pass out in the dung and from this point on there is not much known of their history until they have again found entrance into the sheep.

It has been held that they find their way into stagnant pools and pass a part of their existence living parasitic in the bodies of some water

insect, being finally taken into the stomach of the sheep through drinking. This view is only true in part, if at all, as very serious losses from the ravages of this worm have occurred on high, dry, Iowa prairies, as well as on well drained Ohio pastures, supplied with pure water from deep wells.

It is probable that the young worms may live in the common earthworm, or in other common insects that frequent the grass-land. The true history of *S. contortus* while absent from the sheep would be of great interest and of much practical value, as it is not now known how long a time it will remain alive in the soil, so that in an effort to free our pastures from it by rotation of stock, putting cows or horses to pasture after sheep, we do not yet know whether one year of absence of sheep will serve to purify the pasture or not.

The well known fact that external parasites, such as ticks and scab, more readily attack young sheep or those debilitated from any cause is exactly paralleled by the stomach worm. Older sheep, while not often entirely free from the worms, seldom have enough of them to do much harm. So of lambs, those that are dropped early in winter and reach good size by the time that they are turned on grass, very generally escape the Strongylus, while the later dropped lambs become an easy prey.

The experience of last season would lead one to think that a wet summer is particularly favorable to their increase, and perhaps this is true; drying and sunlight may be deadly to the young worms in their egg coverings. Against this supposition is the fact that warm and sunny Texas often experiences great losses from this cause.

SYMPTOMS.

The symptoms vary considerably. There is disarrangement of the digestion, which may cause either scouring (diarrhea) or constipation. Frequently the constipation succeeds the scouring. The lambs have abnormal appetites, eating irregularly, sometimes very little, then unusual amounts. They often eat rotten wood, earth, etc., and in fact this is the most characteristic symptom. The skin becomes pale, the strength declines, the flesh disappears, the wool is sunken and lusterless. For some reason there seems a greater mortality among ram lambs than among ewe lambs. Few lambs that reach the stage of emaciation ever recover or are of any value if they do recover. In some cases cases death is quite sudden, in others the lamb lingers for weeks or months.

TREATMENT.

The difficulty of treating this disease successfully is due to the very great hardiness of the Strongylus and its ability to endure medicinal substances given to the lamb in the hope of destroying it. There is, too,

usually a large amount of food or water in the stomachs of the lamb, so that the medicine is so diluted before it reaches the fourth stomach that it has lost its effectiveness.

It will, then, be readily seen that if medicines are to be given they should be given when the animal is comparatively empty; when it has been deprived of food for ten hours or longer. And it is well to withhold water for a few hours after giving the medicine.

Hundreds of remedies have been proposed and advised for the cure of this parasitic disease, all of them of nearly equal inefficiency. The use of turpentine is perhaps as simple, as easily within reach of the shepherd, and as efficient as any. The difficulty in destroying the Strongylus with turpentine is to get it to the fourth stomach in sufficient strength and in quantity large enough to kill the parasites without harming the sheep. Turpentine, being very volatile, is readily absorbed into the system of the sheep and acts there as an irritant, almost poisonous in its nature; if given in large doses producing a state much like drunkenness, and death may follow.

The common formula is one part of turpentine to sixteen parts of milk, stirred constantly together and given in doses of from one to three ounces, according to the size and age of the lamb. This is a simply prepared remedy and will not be apt to do harm, if given with care not to exceed the proper dose.

Experience gained the present summer ('97) leads me to think that no certain reliance is to be placed on this prescription. In one case a valuable lamb, after having three doses of the mixture at intervals of 12 hours, died and a post mortem examination showed the worms to be as much alive as though no medicine had been given. Of greater interest, because being the observations of skilled veterinarians and microscopists, are the cases recorded by J. M. McFadyean, of the Royal Veterinary College, Eng. I quote from Journal Royal Agricultural Society, Vol. 8, Part I.

"Put a number of worms into one pound solution of carbolic acid in water; the worms all exhibited active movements when transferred to warm water at the end of ten minutes. When examined at intervals up to two hours afterward they were still active.

"Put a number of worms into one per cent. solution of lysol in water.*

All the worms were motionless when transferred to warm water at the end of ten minutes, and subsequent observation proved that they were dead.

"Put a number of worms into undiluted Fowler's solution. All the worms exhibited active movements when transferred to warm water at the end of ten minutes, and these movements still continued two hours and eighteen minutes later (last observation).

"Put a number of worms into 4 per cent. solution of mercuric chloride in water raised to the body temperature; at the end of ten minutes many of the worms were

*(Lysol is a coal-tar product, similar to our "zenoleums," "chloro naptholeums," etc., used in disinfection and for dipping sheep to destroy external parasites, so at least I am informed. Wing.)

moving a little in the mercuric solution; at the end of fourteen minutes some of them were still active; at the end of nineteen minutes they were all motionless, and when transferred to fresh, warm water they were found to be dead.

"Put a number of worms into a mixture of one of turpentine and twenty-five of milk, well shaken together. When tested at intervals, up to one hour and sixteen minutes afterward (last observation), *the worms were found to be still active.*" (Italics mine, Wing.)

"It must be admitted that these experiments are calculated to give a shock to the confidence which has hitherto been very generally placed in some of the parasiticides mentioned. Turpentine is the sheet anchor in the treatment of diseases caused by the round worm, and there appears to be a considerable body of clinical evidence in its favor, but it will be observed that in the strength of two and one-half per cent. (with milk) it appeared to have no serious effect on worms, (*S. filaria*) that had been immersed in it for over 12 hours. Even with double that strength it had no apparent effect after a two hours exposure to it. In practice it would be impossible to insure a two hour's contact between worms in the stomach of the living sheep and a five per cent. solution of turpentine, because of the necessity of considerably diluting the turpentine for administration, and the rapid absorption that sets in as soon as it comes in contact with the mucous membrane of the stomach. It need hardly be pointed out that, if circumstances are so unfavorable for the insuring of contact between a sufficiently concentrated solution of turpentine and stomach worms, the difficulty is immensely greater in the case of parasites lodged in the bronchial tubes or lung tissue.

"Arsenic also appears to be a very weak parasiticide since a twelve hour's exposure to Fowler's solution, diluted with forty times its bulk of water, left the *S. filaria* still active. This represents the strength of one grain in ten ounces, and a stronger solution could not with safety be kept in contact with the mucous membrane of the stomach for anything like twelve hours. Besides, it will be noticed that even undiluted Fowler's solution (four grains to the ounce of liquid) did not kill stomach worms with a two hour's exposure, and one ounce of Fowler's solution is a poisonous dose for a lamb."

This gentleman concludes that carbolic acid and chloroform are more efficient remedies than turpentine or arsenic and that lysol is yet more efficient; that there is strong hope that it may become valuable as a remedy for the disease.

In administering turpentine there is a better vehicle than milk with which to give it, which is pure, raw linseed oil. The oil prevents so rapid an absorption by the stomach of the turpentine as will take place when milk is the dilutant and at the same time serves as a useful corrective of constipation. Seemingly good results, in truth, the best results ever observed in practice, have been obtained by using the following mixture:

Pine tar	8 parts.
Raw linseed oil	8 "
Turpentine	1 "

The dose is from one to three ounces. An ounce can be conveniently measured in the small vials in which flavoring extracts are sold, or a bottle may be procured at the druggist's of known capacity.

Pine tar is of itself an excellent remedy, the admixture of turpentine increases its efficiency and the linseed oil makes the compound more smooth and non-irritating to the animal.

PREVENTION.

By medication: Admitting that at best treatment is unsatisfactory and will fail to cure really bad cases, yet we can do much in the way of prevention. It is the mature, or nearly mature Stronglyes that are so proof against medicines; at an earlier period there is much more probability of their being destroyed by the medicines used. When there is a suspicion of the presence of this disease in the flock the lambs should all be treated, not merely the sick ones, for it is probable that all are affected, and treatment while the worms are immature and before the animal has lost in vigor will be much more apt to result beneficially than treatment of those far gone in disease. Indeed, it is so little expense and requires so little time to treat an entire flock, that this is by far the better way, doing it two or more times through July and August.

Remedies may also be mixed with salt and kept before sheep at all times, and many are of opinion that benefit will result from this course, although some recent experience tends to throw distrust on the practice.

Preventive management: Thus far the study of these parasites has given us little encouragement. There is, however, a bright side which we will now consider. While medicines may never free our flocks of these pests, or preserve our lambs from their blighting influence, good management will make us quite safe from their attacks. Our hope lies in the fact that lambs are born free from internal parasites of any species and infection comes through eating contaminated food or drinking water polluted with germs.

It must be constantly borne in mind that these parasites are present in nearly or quite all flocks, even in times of health. The older sheep may not suffer perceptibly from the presence of the small number of Strongyli, yet they are constantly passing the eggs with their excrements and thus polluting the herbage, for how long a time we do not know, for at least one year we are certain. If sheep have fresh pasture each year there is not the same opportunity for the young worms to find entrance into the lambs, and thus the number will constantly decrease from year to year.

If, on the other hand, sheep are made to feed over their own droppings from year to year, the worms will increase rapidly in numbers and will sooner or later become sufficient in number to nearly destroy the lamb crop.

The practical lesson is that it is better to have the lambs dropped as early as possible in winter, supposing that food and shelter suitable are provided, for in winter there is very little likelihood of their becoming infested with parasites; then they should be pushed rapidly forward while sucking their mother and weaned, if of suitable age, when first ready to turn on grass. They ought then to have fresh pasture that has had no sheep on it for two years, or at least that had no sheep the preceding year, and no old sheep should be pastured with the lambs.

*2 Ex. Sta. Bul. 91

This plan, although an ideal one, is sometimes difficult of accomplishment. In any event the flock-master can take the lambs away from the ewes at as early an age as is prudent, feeding some grain or ground feed to the lambs before and after weaning, and keeping them during the late summer and early autumn months on land free from infection.

This with the giving of a few doses of medicine to make assurance doubly sure, will almost entirely prevent loss from stomach worms.

Soiling, where it is practicable, is a certain way of keeping lambs healthy, provided they are not permitted to run part of the time on some lot that has been infected by the ewes' droppings.

Too much importance can not possibly be attached to this matter of preventing the invasions of parasites by those making a beginning in sheep husbandry. It is indefinitely better to gain knowledge of them from reading than to have it from practical experience. Even though death does not follow the invasion, because of its small extent, yet the difference in growth of a healthy lamb and one infected will reach as high as 100 per cent.

Study of the native sheep received at the Chicago stock-yards from points east of the Mississippi river warrants the statement that the distribution of the lung-worm and stomach-worm parasites is very general, and that the loss in condition of native sheep and lambs received there is very serious.

With the increase in numbers of our flocks we may expect more than a corresponding increase in numbers of parasites.

Losses in Argentina from lung-worm have amounted to millions of lambs.

Of the other parasitic diseases commonly described, "Liver rot" "Gidd," or brain parasite, and some others are practically unknown in America and it is probable that conditions are unfavorable for their development here.

"Grub in the head" has never, in my experience, done noticeable injury to the flock. With especially valuable lambs which it is desired to carry through their first year without chance of infection, soiling and confining to the yard and sheds is a safe plan. The labor of caring for them is very slight and the increased growth and general healthfulness much more than repays the extra food and labor given. Attention is called to the fact that lambs have for some time been selling at very high prices during the fall and early winter months, caused by the competition between feeders and butchers who bid against each other. Lambs that are dropped early and well fed during summer, by soiling if need be, and given grain regularly, may easily be fattenned for this market and will weigh by September above 100 pounds; and it is probable that greater profit can be had by selling then than at any other time. This market is one in which the farmer of Ohio need not fear the competition of the west, but he must meet this competition when he markets lambs during late winter or in spring.

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